Coastal Ecosystems Response to Climate Change and Human Impact in the Asia-Pacific Region (CERCCHI Project)

Prof. Kazuo NADAOKA: Tokyo Institute of Technology (Japan)

INTRODUCTION

- The natural and human elements of coastal zones in the East Asia and the Pacific are extremely vulnerable to disturbances associated with natural climate variability together with anthropogenic forcing.
- Increase in environmental loads from adjacent watersheds such as nutrients and sediments are of particular concern due to their deleterious effects on coastal habitats - mangroves, seagrasses and coral reefs (see Table 1).
- Coastal zones contain complex interactions between social, economic and environmental systems (see Figure 1 & 2).

Coastal ecosystems are severely damaged:
- over 80% of the reefs are at great risk;
- mangroves have lost 70% of their cover in the last 70 years;
- seagrass bed loss ranges from 20-60% in the last 50 years.

• Management of coastal resources requires consideration of these complex interactions.
• Present investigative efforts are narrow, lacking or produce results that are incompatible to enable understanding of interrelationships across systems.
• There is a need to link science and decision-making stressing the continuum of expertise from basic science to applied science to policy, governance and management.

TABLE 1: Some of the more comprehensively documented field assessments on the effects of human activities (Source: Fabricius (2004), Marine Pollution Bulletin)

<table>
<thead>
<tr>
<th>Location</th>
<th>Activity</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Eutrophication and sedimentation</td>
<td>Declining coral cover</td>
</tr>
<tr>
<td>Gradients away from rivers</td>
<td>Change in coral community composition away from source</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>Excess sedimentation from logging</td>
<td>Declining coral cover, declining biodiversity due to disappearance of sediment species, inhibition of coral settlement</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Excess nutrients and sedimentation</td>
<td>Low coral cover, reduced coral diversity, unaltered vertical extension but low skeletal density in massive corals, increased bioerosion</td>
</tr>
</tbody>
</table>

SCOPE OF THE PROJECT

The project will cover key spatial and temporal aspects of change in natural and human systems in the tropical zone. Viewing these systems as coevolving systems coupled by physical processes (e.g. river hydrology and hydrodynamics) responsible for dynamic interaction and feedback of system elements, the Project will include measurement of dynamic parameters such as carbon, phosphorus and nitrogen (CNP) fluxes, water temperature, salinity, rainfall, sedimentation, tide level and wave action, sediment chemistry, degree, quality and frequency of freshwater flow.

Application of remote sensing data analysis techniques will be a major component of the project to provide a rapid, comparable, and readily available source of spatial records in the Pacific and East Asian region at a larger and broader time scales.

OBJECTIVES of the PROJECT

- Provide an understanding of the driving/forcing effects on socio-economically-induced changes on environmental loads to the tropical coastal ecosystems.
- Develop capacity building through workshops on standardized methods of processing in-situ, remotely-sensed data and environment-related socio-economic surveys.
- Produce an accurate set of multi-date coastal resource information particular to needs of managing changes in the coastal zone and consistent to allow comparison among systems in the region.
- Achieve and apply understanding of the causes and consequences of present and future environmental change of tropical ecosystems in management decisions.
- Strengthen the network of, and reinforce linkages among coastal scientists and managers thru shared expertise and resources.
Coral bleaching is the whitening of coral colonies due to the loss of symbiotic zooxanthellae from the tissues of polyps. This loss exposes the white calcium carbonate skeletons of the coral colony. There is a growing body of evidence linking severe coral bleaching and mortality to increasing rates of global climate change attributed to rising levels of anthropogenic greenhouse emissions (Goldberg and Wilkinson, 2004).

Seagrass ecosystems will respond to the rise in atmospheric CO2 and to the concomitant climate changes associated with global warming, higher frequency of storms and increasing sea level. However, the directions of these responses, positive or negative, are less obvious than those of more direct human disturbances, such as eutrophication and siltation (Borum).

Predator plagues like crown-of-thorns starfish (COTS) are increasingly reported around areas of human activities with 2 strong hypotheses advanced: the plagues may be initiated and certainly exacerbated by either over-fishing of key starfish predators, and/or increases in nutrient runoff from the land favors the planktonic stages of the starfish. (Goldberg and Wilkinson, 2004)

Seagrass decline due to climate change and pollution

Erosion & subsidence

Mangrove deforestation

Gleaning

Natural grazing

Reef exploitation

Threats to Coastal Ecosystems

Project Implementation

Capacity-building through joint workshops and provision of user-friendly decision support tools suited for local management

Development of a policy-relevant prognostic model equipped with environmental quality indicators and optimization technique to evaluate resources and social priorities

Assessment of and relating changes detected in human and natural ecosystems considering hydrologic and hydrodynamic processes by use of physical and ecological models

Analysis of multi-temporal satellite images (e.g., covering a period of 20 years behind) to detect changes in land use patterns and coastal habitats within the region.

Collection and assessment of existing studies and relevant data on changes in the coastal and human impacts in tropical marine ecosystems to identify information gaps

Data and information sharing and dissemination preferably through a website acting as a communication portal for data, information and knowledge base exchange among collaborators and the public.

Fundamentals of the Project Approach

Expected Outcomes & Outputs

a. Impacts of changes to coastal ecosystems in East Asia and the Pacific region as depicted in processed multi-temporal images

b. Stentzartizvd, in-situ data collection protocol, uniform methods for processing remotely-sensed data and socioeconomic surveys

c. An integrated physical and ecological model specific to assessment of environmental changes in tropical ecosystems

d. A science-based, user-driven practical decision support system (DSS) suited for management concerns in coastal zone.

e. A group of coastal scientists in the region proficient in environmental change evaluation methods

f. Managers trained in using DSS for tropical coastal environment.

g. Documentation and other relevant publications for promoting provisional and actual use of the integrated model

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